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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of	:	**Confirmation No. 8131**
Mitsuru KONDO et al.	:	Atty Docket No. 2001-1086A
Serial No. 09/928,449	:	Group Art Unit 2855
Filed August 14, 2001	:	Examiner Lilybett Martir

ROTARY SHAFT AXIAL ELONGATION
MEASURING METHOD AND DEVICE

PATENT OFFICE FEE TRANSMITTAL FORM

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Attached hereto is a check in the amount of $330.00 to cover Patent Office fees relating to filing the following attached papers:

Appeal Brief $330.00

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The Commissioner is authorized to charge any deficiency or to credit any overpayment associated with this communication to Deposit Account No. 23-0975, with the EXCEPTION of deficiencies in fees for multiple dependent claims in new applications.

Respectfully submitted,

Mitsuru KONDO et al.

By [signature]
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March 25, 2004

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BRIEF ON APPEAL

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Appellants in the above-referenced U.S. patent application present herewith their Brief on Appeal along with the fee as set forth in 37 CFR 1.17(c).

REAL PARTY IN INTEREST

The real party in interest in this application is Mitsubishi Heavy Industries, Ltd. of Tokyo, Japan.

RELATED APPEALS AND INTERFERENCES

There are no known related Appeals or Interferences.

STATUS OF CLAIMS

Claims 1-13, 17, 25-28 and 32 have been canceled.

Claims 14-16, 18-24 and 29-31 are pending.

Claims 14-16, 18-24 and 29-31 are the claims appealed.

STATUS OF AMENDMENTS

An Amendment After Final Rejection was filed at the same time as the filing of this Brief on Appeal. Accordingly, the status of the Amendment is not known. However, it is expected that the Amendment will be entered by the Examiner, as the Amendment simply deletes a limitation from claim 14 that was objected to by the Examiner. Claim 14 is discussed below and is presented in the accompanying Appendix based on the assumption that the Amendment has been entered.

SUMMARY OF THE INVENTION

The present invention relates to an axial elongation measuring method and an axial elongation device for a rotary shaft, in particular a gas turbine or steam turbine rotor shaft which elongates in the axial direction during use. Note the "Field of the Invention" as set forth on page 1 of the original specification.

In the prior art as described beginning at line 11 of page 1 of the original specification, and continuing through line 15 on page 2 of the original specification, a gap sensor 4 was used to detect a gap caused by axial elongation of a shaft 1 due to temperature changes. The detection of the axial elongation of the rotary shaft is necessarsy to prevent contact of a moving blade and a stationary blade. However, with the prior art gap sensor 4, if the axial elongation is large, the accuracy of measurement is reduced. Further, the gap sensor 4 requires a certain amount of space in the axial direction.

Thus the present invention, as discussed beginning at line 18 of page 2 and continuing through line 24 of page 2, was developed in part to maintain high accuracy regardless of the amount of axial elongation.

Figs. 1(a)-4 illustrate a first embodiment according to the present invention. A second embodiment described with respect to Figs. 5 and 6 is longer being claimed. Description of the first embodiment begins at line 11 of page 8 of the original specification and continues through line 4 of page 12.

Two marks, for example grooves 10 and 12, are provided on a rotational surface of a rotary shaft 1. They are provided to be oppositely inclined to one another relative to an axial direction of the rotary shaft 1 such that a circumferential direction interval between the marks changes according to the axial direction position along the rotary shaft. The marks form a turned V shape. One of the marks forms a reference mark and the other of the marks constitutes a measuring mark. Note the discussion from line 12 to line 24 of page 8.

A sensor 14 opposes the rotational outer circumferential surface of the rotary shaft 1 and is thus positioned opposite to the marks on the rotational surface of the rotary shaft. As discussed from line 25 of page 8 to line 9 of page 9 of the original specification, the sensor 14 generates a pulse or pulse signal when the grooves 10 and 12 pass by the sensor 14 during rotation of the rotary shaft 1. Noting Figs. 2(a) and (b), the sensor 14 outputs pulses corresponding to a time t1 when the groove 10 passes by the sensor 14 until the groove 12 passes by the sensor 14, and a time t2 corresponding to one rotation of the rotary shaft 1.

Accordingly, if the rotary shaft elongates in the axial direction, and the axial directional position of the grooves 10 and 12 changes relative to the sensor 14, the circumferential directional interval between the grooves at the position of the sensor 14 changes. As such, a pulse change from that having a pulse interval ratio of t1/t2 corresponding to Fig. 2(a) to that of a different pulse interval ratio t12/t22 in Fig. 2(b) corresponding to an axial elongation can indicate the axial elongation of the rotary shaft 1. Thus by measuring a change in pulse interval ratio t1/t2 obtained by sensor 14, the axial elongation of the rotary shaft 1 can be measured. Note the discussion from line 17 of page 9 through line 4 of page 10 of the original specification.

Fig. 3 is a block diagram of an axial elongation measuring device according to the present invention. A pulse interval ratio of pulses detected by sensor 14 is sent to data processing part 16. The axial elongation is obtained at the data processing part 16, and is displayed at a display part 18.

The gap between sensor 14 and the rotational surface of the shaft is constant regardless of the axial elongation. Accordingly, measurement accuracy is maintained constant as compared

with the prior art case discussed in the present application. Note the discussion from line 18 of page 10 through line 4 of page 11.

ISSUES

A primary issue on appeal is whether claims 14-19 and 30-32 are properly rejected by the Examiner as being unpatentable over Matsuda et al., JP 63-313007 (Matsuda) in view of Itoh et al., U.S. Patent 4,112,746 (Itoh). As part of such issue, there are considerations of whether the two references even disclose all of the limitations presented in the claims rejected by the Examiner, whether the two references can in fact be properly combined, and whether they even represent analogous prior art in the first place.

A second issue is whether claim 20 is properly rejected as being unpatentable over Matsuda in view of Itoh and in further view of Hochstein et al., U.S. Patent 4,712,432 (Hochstein). A further issue is whether claims 21-24 and 29 are properly rejected by the Examiner as being unpatentable over Matsuda in view of Itoh and in further view of Savage et al., U.S. Patent 5,315,881 (Savage). Lastly, a further issue is whether claims 21, 23, 24 and 29 are properly rejected by the Examiner as being unpatentable over Matsuda in view of Itoh and in further view of Karim-Panahi et al., U.S. Patent 5,438,882 (Karim-Panahi).

GROUPING OF CLAIMS

Of the Examiner's rejection of claims 14-19 and 30-32 over Matsuda in view of Itoh, claims 14 and 16 stand together. Separate argument is provided for claim 15, however. Separate argument is provided for claim 18, but claim 19 stands or falls together with claim 18. Claim 31 stands or falls together with claim 18, but separate argument is provided for claim 30.

Claim 20 was rejected over Matsuda in view of Itoh and Hochstein, and is provided with separate argument.

Claims 21-24 and 29 were rejected over Matsuda in view of Itoh and Savage, but separate argument is provided for each of claims 21 and 22. Claim 23 stands or falls together with claim 22.

Claims 21, 23, 24 and 29 were further rejected as being unpatentable over Matsuda in view of Itoh and Karim-Panahi. These claims stand or fall together.

ARGUMENT

The claims indicated as being argued separately are distinguished below over the prior art cited by the Examiner in separate sections. As argument applicable to the rejection of one claim may also be applicable to the rejection of another claim, reference to the first presentation of such argument will be made as appropriate for the sake of brevity.

Independent Claim 14 Clearly Distinguishes Over Matsuda in View of Itoh

Claim 14 is directed to a method of measuring axial elongation of a rotary shaft. The first step involves the provision of "two marks on a rotational surface of a rotary shaft such that the marks are oppositely inclined to one another so as to form a V shape turned relative to an axial direction of the rotary shaft so that a circumferential direction interval between the marks changes according to the axial direction position along the rotary shaft." The next step involves the provision of a sensor "opposite to the marks on the rotary surface of the rotary shaft," and the final step of the claim is "measuring the axial elongation of the rotary shaft from a change in an interval ratio of the pulses generated by the sensor when the marks pass the sensor during rotation of the rotary shaft." This combination of steps involved in the claimed method of measuring axial elongation is not suggested by the prior art.

The primary reference relied upon by the Examiner is Matsuda. As the Examiner notes, Matsuda provides two marks 2 and 3 on a surface where the mark 2 is inclined relative to an axial direction of shaft 1. Respective sensors 4 and 5 are provided for marks 2 and 3, which are connected with a time computer, which is connected with a computer 7.

The following differences become immediately apparent in comparing the limitations of claim 14 with Matsuda. First, the marks in Matsuda are not "oppositely inclined to one another so as to form a V shape turned relative to an axial direction of the rotary shaft." Rather, the mark 3 is straight and the mark 2 is inclined. They do not form a V shape and are not oppositely

inclined to one another. Second, there is not a "sensor opposite to the marks." That is, claim 14 requires providing a sensor opposite to the marks (plural). However, in Matsuda sensor 4 is opposite to mark 2 and sensor 5 is opposite to mark 3. Third, claim 14 requires measuring the axial elongation of the shaft "from a change in an interval ratio of the pulses generated by the sensor when the marks pass the sensor during rotation of the rotary shaft." Matsuda does not employ change in interval ratio of pulses generated by the sensor to measure the axial elongation of the rotary shaft. By contrast, Matsuda measures axial elongation of a shaft by pulse time difference t1-t2 from the measurement time in a no-elongation reference time as shown in Fig. 2, and the rotational speed of the shaft found from intervals between output signals of the sensors 4 and 5. There is no disclosure or suggestion from Matsuda to measure axial elongation of the shaft using interval ratios without regard to the rotational speed of the shaft.

With the present invention, axial elongation is measured by measuring changes in interval ratio pulses generated by the sensor upon the passing of the reference mark and measuring mark. Consequently, axial elongation of the shaft can be measured at any rotational speed regardless of the speed. This is not the case with Matsuda.

In the final rejection, the Examiner takes the position that Matsuda discloses the use of a computer device "which is operable to determine changes in interval ratios." This position by the Examiner is respectfully traversed. Matsuda discloses a computer, but it is not disclosed as being operable to measure axial elongation of a rotary shaft from a change in interval ratio of pulses generated by a sensor as claimed. Whether the computer device of Matsuda might be capable of doing so if it was in fact programmed to do so is another question and entirely speculative.

On page 3 of the Office Action the Examiner further notes that Matsuda discloses the use of a reference mark arranged similarly to the mark in Fig. 5 of the present application. However, this embodiment is no longer being claimed.

The Examiner does go on to acknowledge that Matsuda fails to teach a re-orientation of one of the markings so that the two markings are oppositely inclined to one another to form a V shape and acknowledges that the calculation of the resulting data by monitoring a change in

interval ratio is not disclosed by Matsuda. However, the Examiner then relies upon the secondary reference to Itoh.

Itoh discloses an opto-electronic tensile testing system for use on a specimen of rubber or other material that has a test region defined at a reduced mid portion. The Examiner cites markings 44 which are monitored to detect elongation of specimen 40 while the specimen is distended. As the Examiner notes, column 32, lines 40-43 discuss "an electronic computer or a simpler digital comparison circuit or ratio computing circuit." The comparison that is being made by this "ratio computing circuit" is discussed in the preceding paragraph. As noted in this paragraph, a count made by a counter 338 represents a length L' of a reference length member. This count is used for comparison with the length L of the test region as measured through a television camera. The counter 330 is reset upon each complete scanning of scene M.

It is not seen how Itoh discloses or suggests the present invention from any possible combination with Matsuda. The advantage of employing an interval ratio of pulses in the present invention is that axial elongation of the shaft is determined irrespective of the rotational speed of the shaft. As the Examiner acknowledged, this is not disclosed or suggested from Matsuda. Itoh suggests nothing whatsoever that would suggest a modification of Matsuda, however, to arrive at the present invention. It does not recognize the advantage of being able to determine elongation of the shaft irrespective of its rotational speed. The apparent problems and considerations in testing a specimen as discussed in Itoh do not appear to relate to the present invention. Thus one of ordinary skill in the art would not have been motivated to attempt any combination. There is no suggested advantage for any such combination from Itoh.

Put otherwise, the prior art does not recognize a deficiency to be cured by some other reference with respect to Matsuda. Neither Matsuda nor Itoh suggests a possible improvement or advantage to be gained from modifying Matsuda. It is only the present inventors that have identified problems with measuring axial elongation over a wide range of a rotary shaft while maintaining accuracy. These problems are not addressed by either Matsuda or Itoh. Accordingly, neither suggests the particular combination as set forth in claim 14. To be properly combined with and modify Matsuda, assuming for purposes of argument that Itoh is analogous art, the art

must recognize some advantage or motivation to be gained from making the modification. However, there is no problem identified or advantage suggested from Matsuda and Itoh from which one of ordinary skill in the art would have found it obvious to make a combination.

Noting page 4 of the final Office Action, the Examiner cites the case of *In re Japikse*, 86 USPQ70, as standing for the proposition that "rearranging parts of an invention involves only routine skill in the art." The Examiner is referring to the V shape of the markings. However, with the present invention, the V shape enables one sensor to detect both markings during rotation of the shaft. Thus an additional advantage of the present invention is the ability to use a single sensor to detect pulses and measure elongation of the rotary shaft. Accordingly, the Examiner's case citation appears clearly irrelevant to the present situation. In the present situation, there is a clear advantage and benefit gained from the arrangement not identified by the prior art. As such it is not simply a rearrangement of parts but is an inventive aspect.

Itoh does not disclose or suggest two marks that are oppositely inclined to one another. Itoh further does not disclose or suggest a V shape of marks. Itoh is not concerned with a rotary shaft whatsoever. Nor does Itoh disclose a sensor opposite to a plurality of marks on a rotational surface of a rotary shaft as claimed. Nor does Itoh recognize an advantage from employing an interval ratio of pulses generated by a sensor when the marks pass the sensor in measuring axial elongation. The present invention has recognized that this allows the determination of the elongation irrespective of the rotational speed of the shaft. Such advantage is not disclosed or suggested by the reference to Itoh.

The Examiner further stated that using the V shape makes the device highly accurate over a wide measurement range. This may in fact be the case, but it is not taught by the references cited by the Examiner. Accordingly, the Examiner's conclusion is unsupported by any evidence of record.

The Examiner further stated that determining variations in the ratio of pulses to obtain length or distance measurements is only a mathematical manipulation of data well known in the art. However, this conclusionary statement sidesteps the problem that the present invention has identified a particular way of determining axial elongation irrespective of the rotary speed of the

shaft, and provides a specific arrangement for doing so. The prior art has not recognized this arrangement or this way of determining the axial elongation. To simply recharacterize the prior art as being able to do this sidesteps the fact that there is no evidence that suggests doing so. Thus the Examiner's statements of what is "commonly known" in the art and obvious to one of ordinary skill in the art are respectfully traversed as being completely unsupported by evidence of record. Again, the Examiner's statements are conclusionary and attempt to dismiss Appellants' claims, which provide a novel and unobvious combination of features that address a problem not recognized in the prior art and provide an advantage that is not suggested by the prior art.

Thus, the method of claim 14 is clearly not suggested by any permissible combination of Matsuda and Itoh. The method provides the advantage of allowing a single sensor to be used to measure axial elongation of a rotary shaft by employing changes in an interval ratio of pulses. Thus the method can use a single sensor, a feature not addressed by the prior art, and can determine the elongation irrespective of rotary speed of the shaft. These advantages are not recognized by the prior art and claim 14 is clearly patentable thereover. Indication of such is respectfully requested.

The Itoh Reference is Non-Analogous Art and may not be Considered by the Examiner

In order for a reference to be properly combinable with another reference in an obviousness-type rejection, the reference must be analogous prior art, i.e. analogous to the invention. A two part test has been established for determining whether a reference is analogous prior art. The Examiner's attention is directed to MPEP §2141.01(a), which sets forth this test. Thus, in order to rely on a reference as a basis for rejection, the reference <u>must</u> either (1) be <u>in the field of Applicant's endeavor</u>, <u>or if not</u>, then (2) be <u>reasonably pertinent to the particular problem with which the inventor was concerned</u>. See the citations in this section of the MPEP.

Applying the first test, the field of the present invention is an axial elongation measuring method for a rotary shaft, and a device therefor. More particularly, the present invention relates to an axial elongation measuring method and device used with a gas turbine or steam turbine rotor shaft to prevent contact between parts thereof during operation due to thermal expansion. The

field of Itoh is a tensile testing system, more specifically an opto-electronic testing system. More particularly, Itoh relates to a testing system for testing stress-strain properties of materials that are under tension for materials such as rubbers, fibers and plastics. It is respectfully submitted that clearly the Itoh patent is not in the same field as the present invention. The present invention addresses a practical situation to prevent an undesirable occurrence during operation of a device employing a rotary shaft. Itoh relates to a materials testing system for testing stress-strain properties, which is clearly not the same field as the present invention. Thus, the second step of the test must be looked to.

Applying the second step, the problems with which the present invention are concerned are the prior art use of a gap sensor, requiring measurement over a large gap. Further, the present invention was also concerned with reducing the amount of space required for such measurement. By its terms, Itoh is concerned with improving a tensile testing system, avoiding troublesome preparation of specimens, permitting ready mounting and demounting of specimens, and being capable of simultaneously and individually testing a plurality of specimens. Note the bottom of column 1 of Itoh. Thus Itoh is not reasonably pertinent to the problems of using a gap sensor and space considerations in determining elongation of a rotary shaft.

From the above, it is seen that Itoh does not rise to the level of analogous prior art with respect to the present invention. As such, the reference is not permitted under the law to be considered together with the Matsuda reference for consideration in making a combination rejection under 35 U.S.C. §103.

In the final Office Action, in section 8 on page 11 of the Office Action, the Examiner responds to this argument by re-stating the test described above, and argues that in this case "both inventions explore and define the axial elongation of specimens, in which observations are made in a similar manner." However, the Examiner's characterization is irrelevant to the test. The test is quite specific as to the manner in which it is determined whether a reference is analogous prior art. One first looks to the field of the invention (the invention of the present application). If the reference is not within the same field, then it must be determined whether the reference is still

reasonably pertinent to particular problems involved with the present invention. As discussed above, Itoh clearly fails these tests.

The Examiner's characterization as both inventions exploring and defining axial elongation of specimens could be argued to be a consideration that they are within the same field. However, the field of the present invention is a method and apparatus for determining axial elongation of a rotary shaft, particularly with respect to gas turbine or steam turbine rotor shafts. The shafts are not "specimens" to be tested, but are practical devices in a practical situation in which it is desired to avoid contact between parts. Thus it is respectfully submitted that the Examiner has mischaracterized the field of the present invention and that Itoh does not represent analogous prior art. For this reason alone the combination of references cannot stand and the rejection should be reversed.

Claim 15 Further Distinguishes over Matsuda and Itoh

Claim 15 further requires that the interval ratio of the pulses be a ratio of the time from detection of the reference mark until detection of the measuring mark to the time it takes for one rotation of the shaft is determined by the sensor. As was described with respect to claim 14, both Matsuda and Itoh are silent with respect to the use of an interval ratio to determine axial elongation of a rotary shaft. Thus there is no recognition in either reference of this interval ratio as defined in claim 15. Accordingly, for this additional reason, claim 15 patentably distinguishes over Matsuda and Itoh.

Claim 18 Further Distinguishes over Matsuda and Itoh

The majority of the arguments presented above with respect to claim 14 apply also with respect to claim 18, but claim 18 is an apparatus claim. Accordingly, such arguments will not be repeated.

Claim 18 similarly recites two marks on a rotational surface of a rotary shaft, the marks being oppositely inclined to one another relative to an axial direction of the shaft. However, the claim does not specifically recite the V shape. However, the claim does recite "a sensor

positioned opposite to the marks on the rotational surface of said rotary shaft." Thus, the arrangement defined by claim 18 similarly permits a single sensor to be used with two marks as the sensor is positioned opposite to both the marks.

Claim 18 further recites a data processing part that is operable to determine the axial elongation of the rotary shaft from the change in interval ratio of the pulse is generated by the sensor when the marks pass the sensor during rotation of the rotary shaft. Neither Matsuda nor Itoh disclose or suggest such a data processing part. That is, neither discloses nor suggests a data processing part that is operable to determine the axial elongation from the change in interval ratio as discussed above with respect to claim 14.

Claim 20 Further Distinguishes over the Prior Art

Claim 20 was rejected by the Examiner by Matsuda and Itoh and in further view of Hochstein. The Examiner acknowledges that Matsuda does not teach two grooves in a V shape. However, the Examiner finds this obvious from Hochstein.

Hochstein is directed to a non-contact inductively coupled leakage flux torque sensor. Its particular application is measurement of torque in a power steering system of an automotive vehicle.

Hochstein does not represent analogous prior art. Hochstein is not within the field of the present invention (measuring axial elongation of a rotary shaft). Nor does it relate to the problems with which the present invention was concerned. That is, it does not relate to problems associated with the prior use of a gap sensor, requiring measurement over a large gap, or reducing the amount of space required for measurement of an axial elongation of a rotary shaft. As such, Hochstein may not be considered in combination with Matsuda, and this rejection must be reversed.

Further, Hochstein does not suggest two marks on a rotational surface of a rotary shaft that are oppositely inclined to one another relative to the axial direction of the rotary shaft and forming a V shape as required by claim 20. Note the above discussion with respect to claim 14, furthermore, regarding the advantage of this shape.

The Examiner's characterization of the claimed modification as merely constituting a change in shape of a known element in a known apparatus is incorrect. The Examiner's statement that "modifying the shape of the markings or grooves making them in the shape of a 'V' shape for the purpose of experimentally determining a shape of said grooves that would allow said measurements to be made over wide measurement ranges therefore making said apparatus versatile and reliable" is clearly a hindsight rationalization for the rejection. There is no basis for any of these statements in the prior art cited by the Examiner.

Claim 22 Further Distinguishes over the Prior Art of Record

Claim 22 was rejected by the Examiner by Matsuda and Itoh and in further view of Savage. The Examiner acknowledged that Matsuda and Itoh do not have two wire members in a V shape. Thus, initially, please see the above discussions with respect to claim 14 and claim 20.

Savage suffers from the same deficiencies as Hochstein, apparently. Savage is directed to detecting transmission of torque through shafts by use of magnetostrictive material. It does not suggest two marks on a rotational surface of a rotary shaft that are oppositely inclined to one another and form a V shape. While Savage does appear to suggest wire members, it is also not analogous prior art for the same reasons as discussed above with respect to Hochstein.

Claim 30 Further Distinguishes over the Prior Art Cited by the Examiner

Claim 30 recites limitations similar to those of claim 15. Accordingly, claim 30 further distinguishes over the prior art of record for the same reasons as discussed above with respect to claim 15, but claim 30 depending from claim 18.

Response to Examiners Arguments

The majority of the Examiner's arguments have been addressed above. The following general comments are noted.

The Examiner has taken position that rearranging parts of an invention involve only routine skill in the art. However, it is submitted that this might only be the case in a situation

where such rearrangement makes no difference. In the present case, the "rearrangement" addressed by the Examiner provides a distinct functional advantage, and cannot properly be rejected on this basis. This similarly applies to the consideration of parts as being by "merely duplicating" the parts.

The Examiner has argued that both inventions (Matsuda and Itoh) explore and define axial elongation of specimens wherein observations are made in a similar manner. This is respectfully submitted to be incorrect. The observations are clearly not made in a similar manner if the references are properly looked at. Further, it is not seen where there is any basis for concluding that one of skill in the art could have expected that the manipulation of data from both references could exist without departing from the structural scope of the invention. It is not even clear what this statement means. It seems as if the Examiner is suggesting that any rearrangement of the various parts from either reference could be made so as to result in the claimed invention. However, this is clearly hindsight reasoning, without any proper basis in evidence in the references.

CONCLUSION

From the above, it is respectfully submitted that all of the claims pending in the present application have been amended to be definite. Further, the rejections made by the Examiner are clearly in error, and must be reversed. Such reversal is, accordingly, requested.

Respectfully submitted,

Mitsuru KONDO et al.

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APPENDIX

14. A method of measuring axial elongation of a rotary shaft, comprising:

providing two marks on a rotational surface of a rotary shaft such that the marks are oppositely inclined to one another so as to form a V shape turned relative to an axial direction of the rotary shaft so that a circumferential direction interval between the marks changes according to the axial direction position along the rotary shaft;

providing a sensor opposite to the marks on the rotational surface of the rotary shaft, the sensor being operable to generate pulses when the marks pass the sensor during rotation of the rotary shaft; and

measuring the axial elongation of the rotary shaft from a change in an interval ratio of the pulses generated by the sensor when the marks pass the sensor during rotation of the rotary shaft.

15. The method of claim 14, wherein the marks comprise a reference mark and a measuring mark, and wherein the interval ratio of the pulses is the ratio of the time from detection of the reference mark until detection of the measuring mark to the time it takes for one rotation of the rotary shaft as determined by the sensor.

16. The method of claim 14, wherein the sensor is fixed.

18. A rotary shaft axial elongation measuring device, comprising:

two marks provided on a rotational surface of a rotary shaft, wherein said marks are oppositely inclined to one another relative to an axial direction of the rotary shaft such that a circumferential direction interval between the marks change according to the axial direction position along the rotary shaft;

a sensor positioned opposite to the marks on the rotational surface of said rotary shaft, said sensor being operable to generate pulses when said marks pass said sensor during rotation of the rotary shaft; and

a data processing part operable to determine axial elongation of the rotary shaft from a change in an interval ratio of the pulses generated by said sensor when said marks pass said sensor during rotation of the rotary shaft.

19. The rotary shaft axial elongation measuring device of claim 18, wherein said plurality of marks comprises a reference mark and a measuring mark.

20. The rotary shaft axial elongation measuring device of claim 19, wherein said reference mark and said measuring mark comprise two grooves in the rotational surface provided so as to form a V shape.

21. The rotary shaft axial elongation measuring device of claim 20, wherein said sensor is any one of a capacitance type gap sensor, an eddy current gap sensor and a photoelectric sensor.

22. The rotary shaft axial elongation measuring device of claim 19, wherein said reference mark and said measuring mark comprise two wire members fitted on the rotational surface of the rotary shaft in a V shape.

23. The rotary shaft axial elongation measuring device of claim 22, wherein said sensor is any one of a capacitance type gap sensor, an eddy current gap sensor and a photoelectric sensor.

24. The rotary shaft axial elongation measuring device of claim 19, wherein said sensor is any one of a capacitance type gap sensor, an eddy current gap sensor and a photoelectric sensor.

29. The rotary shaft axial elongation measuring device of claim 18, wherein said sensor is any one of a capacitance type gap sensor, an eddy current gap sensor and a photoelectric sensor.

30. The rotary shaft axial elongation measuring device of claim 18, wherein said plurality of marks comprises a reference mark and a measuring mark, and wherein the interval ratio of the pulses is the ratio of the time from detection of the reference mark until detection of the measuring mark to the time it takes for one rotation of the rotary shaft as determined by said sensor.

31. The rotary shaft axial elongation measuring device of claim 18, wherein said sensor is fixed.